AUTOMATED CHICKEN COOP UNSTACKER

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AUTOMATED CHICKEN COOP UNSTACKER

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INTRODUCTION

Most broilers are transported from broiler houses to processing plants in standard coops stacked on trucks. At the plant, the coops must be unstacked and transferred to conveyors leading into the plant. This unloading operation is one of the major problem areas at the processing plant. First, since the vertical and horizontal distances from coop stacks on the truck to the conveyor vary from 2 to 8 feet, workers are tempted to toss the coops onto the conveyor. This bruises the chickens, thus downgrading the product, and also damages the coops. Second, working conditions in the unloading area are unpleasant because of dust, odors, and climatic conditions. It is therefore difficult to obtain workers for these tasks.

Many new ideas are being tried in the industry to improve receiving operations at the processing plant. These new ideas include (1) an overhead electric hoist arrangement which uses forks or clamps to lift stacks of coops from the truck bed and place them on conveyor systems leading into the plant, (2) an electromagnetic rail that lifts coops off of the trucks and deposits them on a roller or belt conveyor network, (3) palletized coop-handling systems for removing 20 to 40 coops at a time from a truck by a forklift or in units of 20 coops by a squeeze-lift truck, and (4) a permanently mounted battery system in which the broilers are removed from the cages while on the truck and are immediately hung on the defeathering line.

All of these semimechanical systems have value in that they can reduce bruise damage to the birds and manual labor required in unloading them. None of these systems, however, meet all the conditions and requirements of processing plants in different geographic areas. We report here the development of an automated chicken coop unstacker that meets most of the needs of the broiler-processing industry. It receives stacks of coops from a truck, moves the stack into a tower, lifts the stack, and dispenses the coops one at a time into the processing plant. It handles common sizes and styles of coops and provides a constant supply of birds to the plant. The unit is simple in construction, rugged and reliable, easy to maintain, and economical to own and operate. Testing was done at a commercial processing plant.

UNSTACKER DESIGN

The major components of the unit (fig. 1) are a powered feed conveyor; an unstacking tower consisting of a tower conveyor, a lift platform, a powered, spring-loaded chain, and pneumatic coop-discharge wheels; and a powered coop-discharge conveyor.

Powered Feed Conveyor

For the unstacker to operate efficiently, a constant supply of stacked coops is required. The powered feed conveyor functions as a temporary holding facility for stacks of full c
and automatically transfers them to the
conveyor as required. The prototype
(fig. 2) has a maximum storage capa
coops (6 stacks of 6 coops each). Thi
can be increased by lengthening the
or by increasing the tower height to
date higher stacks. The experimenta
is approximately 12 feet long, 4 feet
28 inches wide. Some of the constr
tails of the conveyor are shown in f

The conveyor supplies stacks of cc
unstacking tower on demand. The c
the unit supply one stack of coops to
and at the same time position anothe
the entrance for quick transfer to

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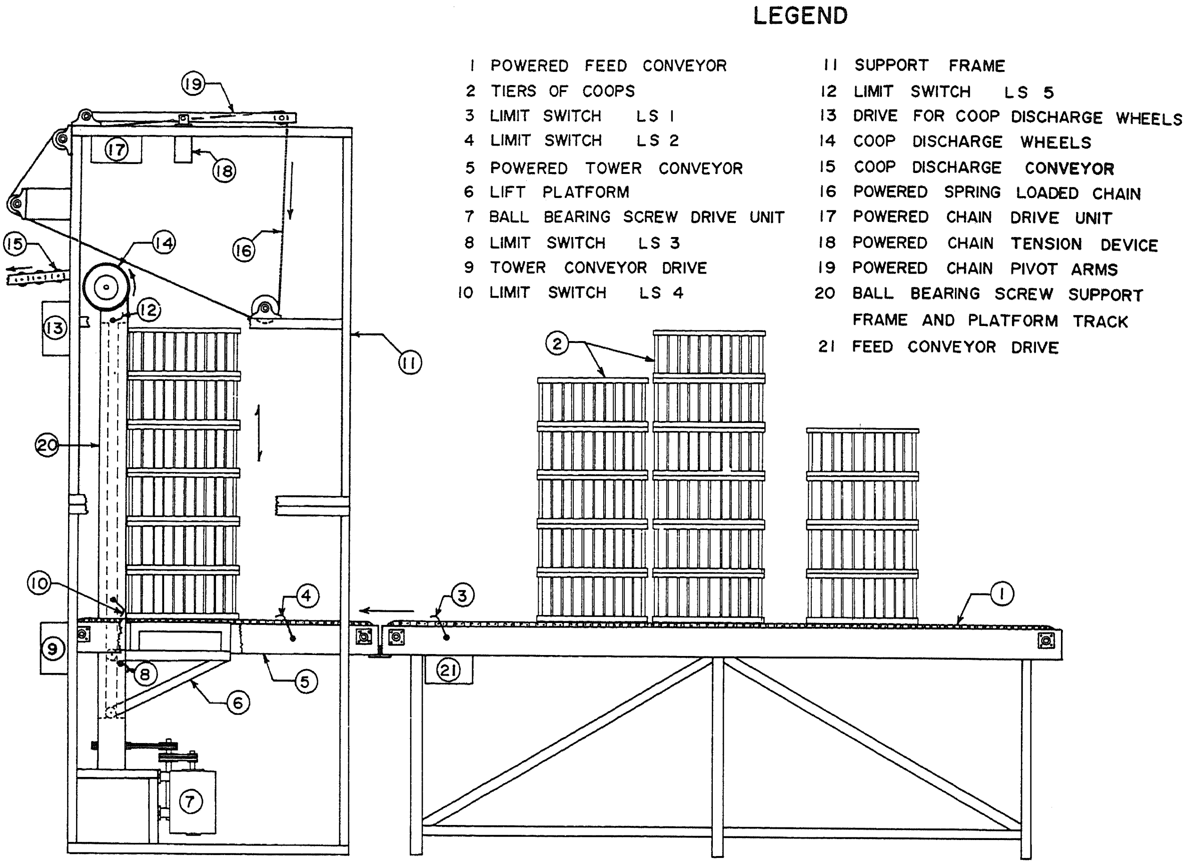

FIGURE 1.—Unstacker components, side view.

The coops are moved toward the tower by two powered No. 60 double-pitch drag chains which travel the length of the conveyor. Power is supplied to the chains by a 1½-horsepower gearmotor. The output shaft from the gear box, rated at 35 revolutions per minute, coupled through dual V-belt sheaves with a drive ratio of 1 to 1, provides a linear speed on the conveyor of approximately 52 feet per minute. This experimentally determined speed will supply more than 16 coops (stacked 6 high) per minute to the tower, and single stacks can be advanced the length of the conveyor without tilting over.

FIGURE 2.—Conveyor loaded with 20 coops.

Tower Conveyor

The mechanical design of the tower conveyor (fig. 11) allows clearance for the lift platform to ascend and descend between the powered drag chains. This conveyor is an integral part of the unstacker, and its function is to position a stack of coops on the lift platform. Power is supplied to the conveyor by a 1-horsepower gearmotor rated at 35 revolutions per minute on the output shaft. With sprockets having a 1.11-to-1 drive ratio, the linear speed on the conveyor is approximately 60 feet per minute. The increase in speed above the powered feed conveyor provides automatic spacing of stacks on the tower

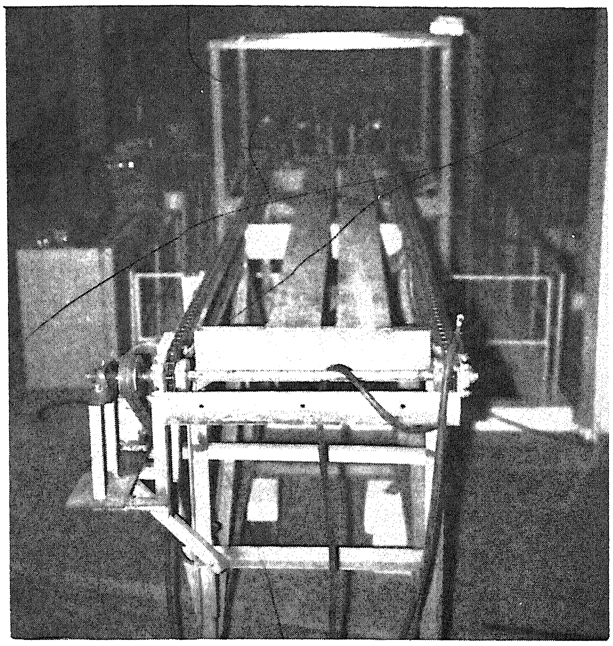

FIGURE 3.—Metal plates on conveyor bed prevent broken coop bottoms from jamming the operation of the conveyor.

conveyor and decrases the hold time of the platform. The hold time is the time the lift platform is at a rest position while receiving a load. Separation of stacks on the tower conveyor prevents interlocking of the coops on the lift platform with the following stack.

Lift Platform

The lift platform, which supports and elevates a stack of coops, is raised and lowered by a powered ball-bearing screw. The constructive details of the lift platform and track frame are shown in figures 12 and 13. The ball-bearing screw (fig. 4) is driven by a 2-horsepower motor. The motor is equipped with a fail-safe brake which stops the lift platform at control points and is also a safety feature. In the event of an electrical power interruption, the brake stops and holds the platform until power is restored. The motor, coupled through a jackshaft arrangement with dual V-belt sheaves, provides the means for varying the speed of the ball-bearing screw and maintaining proper belt tension. The ball-bearing screw is a Saginaw model 1500–1000 with standard rolled threads. It has a 1.5-inch ball circle diameter and a 1-inch pitch. For each revolution of the screw, the nut travels vertically 1 inch. The rotation speed of the ball-bearing screw determines the travel time of the lift platform. The operating speed of the screw on the prototype upstacker was set at approximately 430 revolutions per minute, giving a lift speed of 430 inches per minute. With the platform travel limited to approximately 66 inches, the time required to elevate and dispense six coops is approximately 9.2 seconds. When the platform reaches the top position, it is stopped and held for 1 second so that the bottom coop can be moved out. Then the platform descends in 9.2 seconds and is in position to receive and elevate another stack. The total cycle from bottom to top and return takes approximately 19.4 seconds.

No. 40 roller chains with single pitch were selected for the tension arms because they provide flexibility and good wraparound characteristics for positive control of a coop. The chains are powered by a ¾-horsepower gearmotor with output rated at 35 revolutions per minute. With sprockets having a 2.4-to-1 drive ratio, the chains travel at a linear speed of approximately 100 feet per minute. This rate, determined by experimental testing, is compatible with the speed of the lift platform. The relationship between the chain speed and the platform speed is critical in providing a smooth flow of coops through the unstacker.

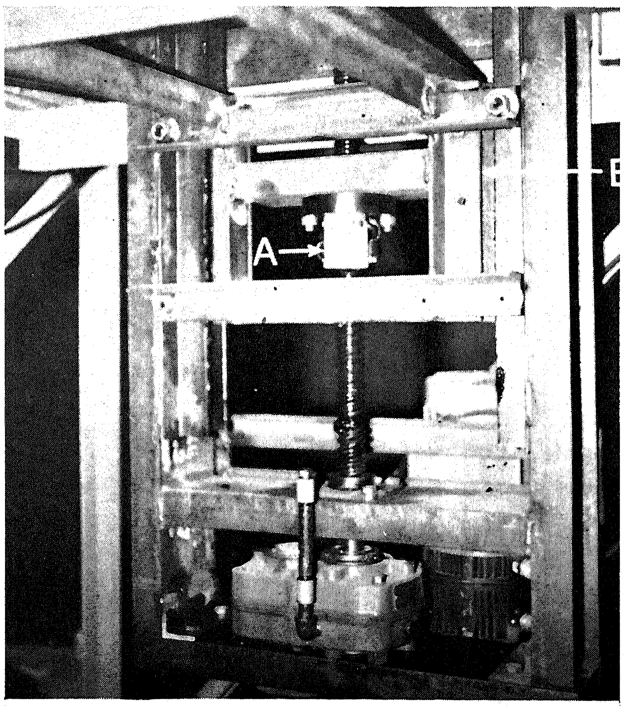

FIGURE 4.—The nut of the ball-bearing screw (A) is bolted to the lift platform (B).

Coop-Discharge Mechanism

The coop-discharge mechanism is composed of four pneumatic tires and three powered, spring-loaded chains. The tires and chains work as a unit to impel coops continuously onto a discharge conveyor as fast as the lift mechanism raises the stack. The four equally spaced wheels are mounted on the top of the platform track (fig. 14). Power to the tires is supplied by a 3/4-horsepower gearmotor with a rated output of 35 revolutions per minute. The wheels (fig. 1), rotating in a counterclockwise direction, "denest" the top coop and lift one side in an upward direction. The size of the tires (4.10/3.50–4) and their location on the platform track determine the angle of tilt exerted on the coop and the smoothness of the discharge. The pneumatic wheels were selected for their ability to deflect and provide positive traction on the coop. The tires were inflated to approximately 30 pounds per square inch.

The mechanical design and location of the powered chain-tension arms are shown in figures 15 and 16. Tension is maintained on each chain independently by two coil springs. Each spring is approximately 8 inches long and 1½ inches in diameter, with a spring rate, *K*, equal to 60. (For each inch of compression by the tension arm, 120 pounds of energy is stored.) The maximum deflection of the tension arms is set at 4 inches. At maximum deflection, each arm exerts approximately 480 pounds of energy on the coop. The total energy imparted to the coop through the three tension arms is approximately 1,400 pounds.

UNSTACKER OPERATION

Figure 5 shows the unstacker ready to begin operation: the powered feed conveyor and the tower conveyor are empty, and the lift platform is in the bottom position ready to receive a stack of coops. When the electricity is turned

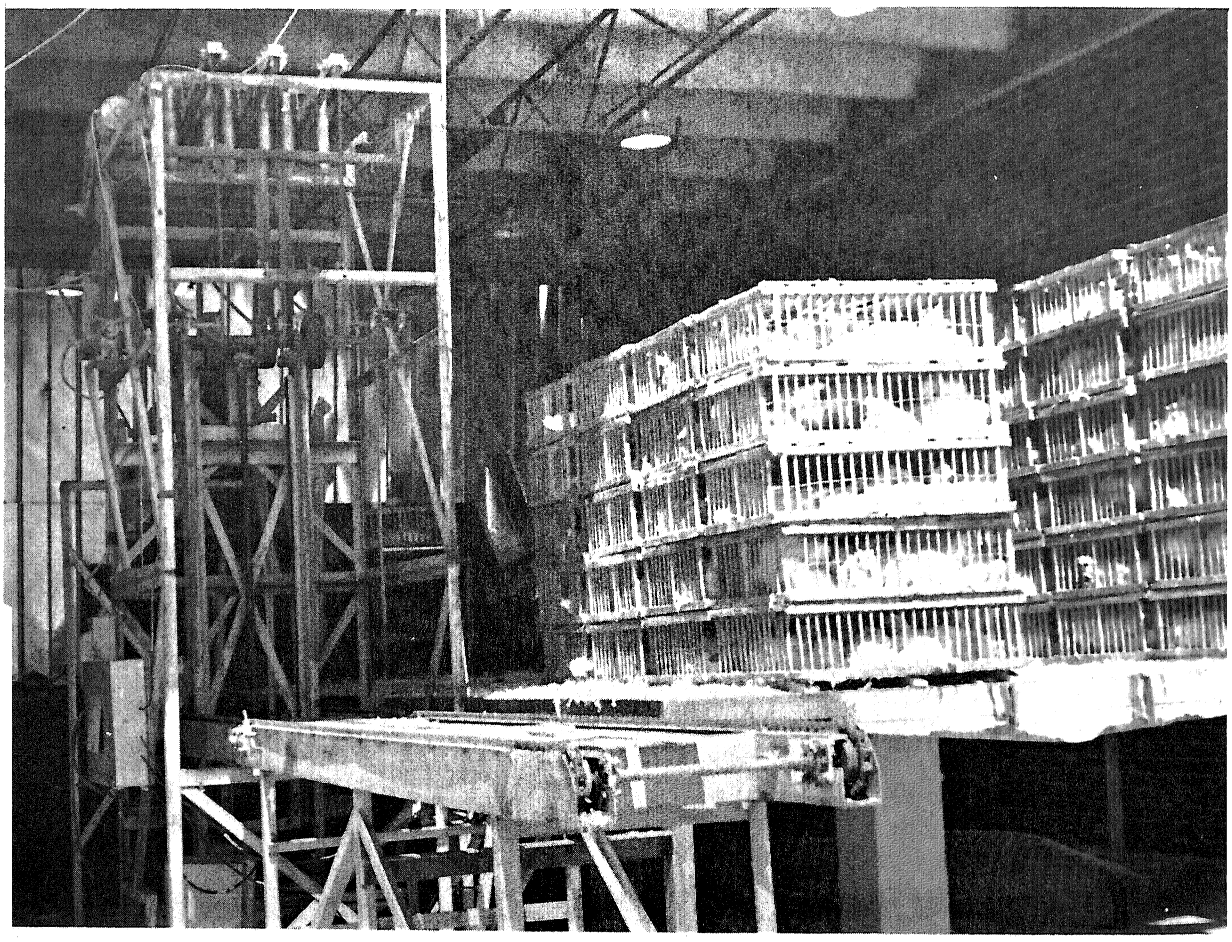

FIGURE 5.—Unit ready to begin operation.

on, the powered feed conveyor, the coop-discharge wheels, the powered tension chains, and the tower conveyor begin operation. Stacks of coops are now placed on the feed conveyor, and advance toward the tower. As the first stack is transferred from the feed conveyor to the tower conveyor (fig. 6) and contacts limit switch 2 (LS–2, fig. 1), the feed conveyor stops. When the stack clears limit switch 2, the feed conveyor is reenergized and continues to run until another stack contacts limit switch 1 (fig. 1). The second stack is then in position to be transferred to the tower conveyor on demand.

The stack of coops on the tower conveyor continues inward to the platform track frame and contacts limit switch 4 (LS–4, fig. 1). At this time the coops are in position on the lift platform. The contact with LS–4 stops the tower conveyor and energizes the ball-bearing screw-drive unit, which begins elevating the stack of coops (fig. 7) toward the unstacking mechanism.

As the platform continues elevating stack number one, the top coop contacts the powered, spring-loaded chains (fig. 8). The chains, moving in a clockwise direction, force the coop against the discharge wheels. As the coop continues in an upward direction, the pressure applied by the chains increases and the pneumatic wheels traveling in a counterclockwise direction lift the side of the top coop (fig. 9) from

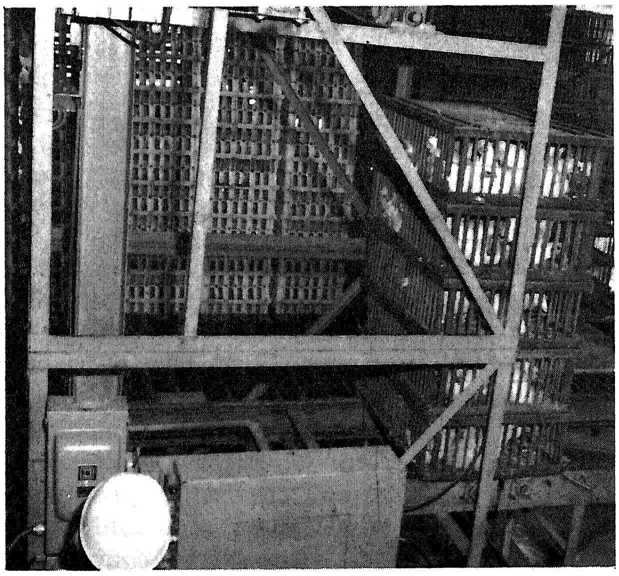

FIGURE 6.—Coops transferring from powered feed conveyor to tower conveyor.

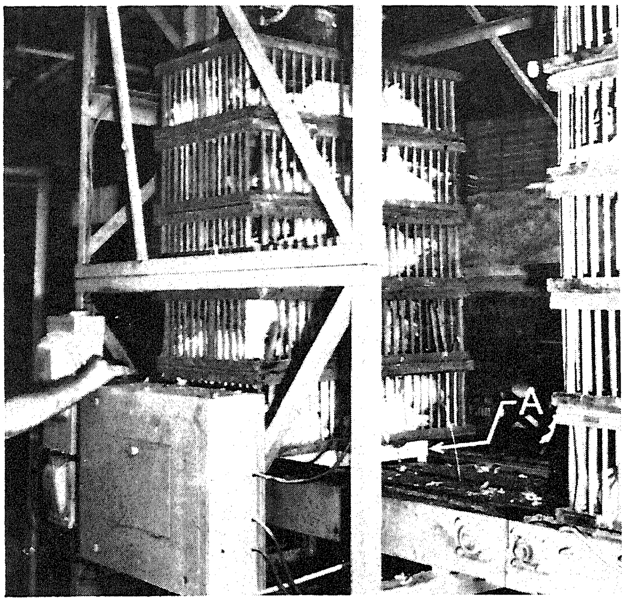

FIGURE 7.—Platform (A) elevating a stack of coops.

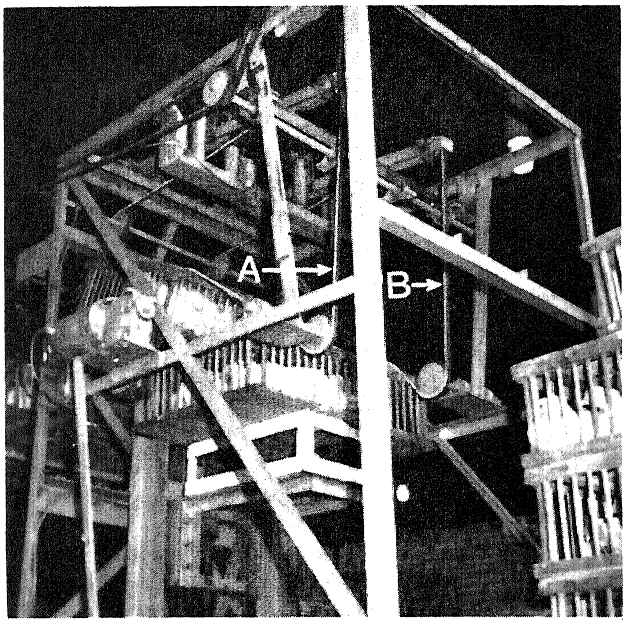

FIGURE 8.—Pressure is applied to the powered tension chains (A) and (B). An additional powered tension chain was installed between (A) and (B) on the final experimental design.

the adjacent coop. When the coop bottom passes the centerline of the wheels, maximum coop separation occurs and discharge begins. The discharge wheels continue to lift the leading edge of the coop, and maximum pressure is developed in the tension arms, which now begin to exert a horizontal force on the coop.

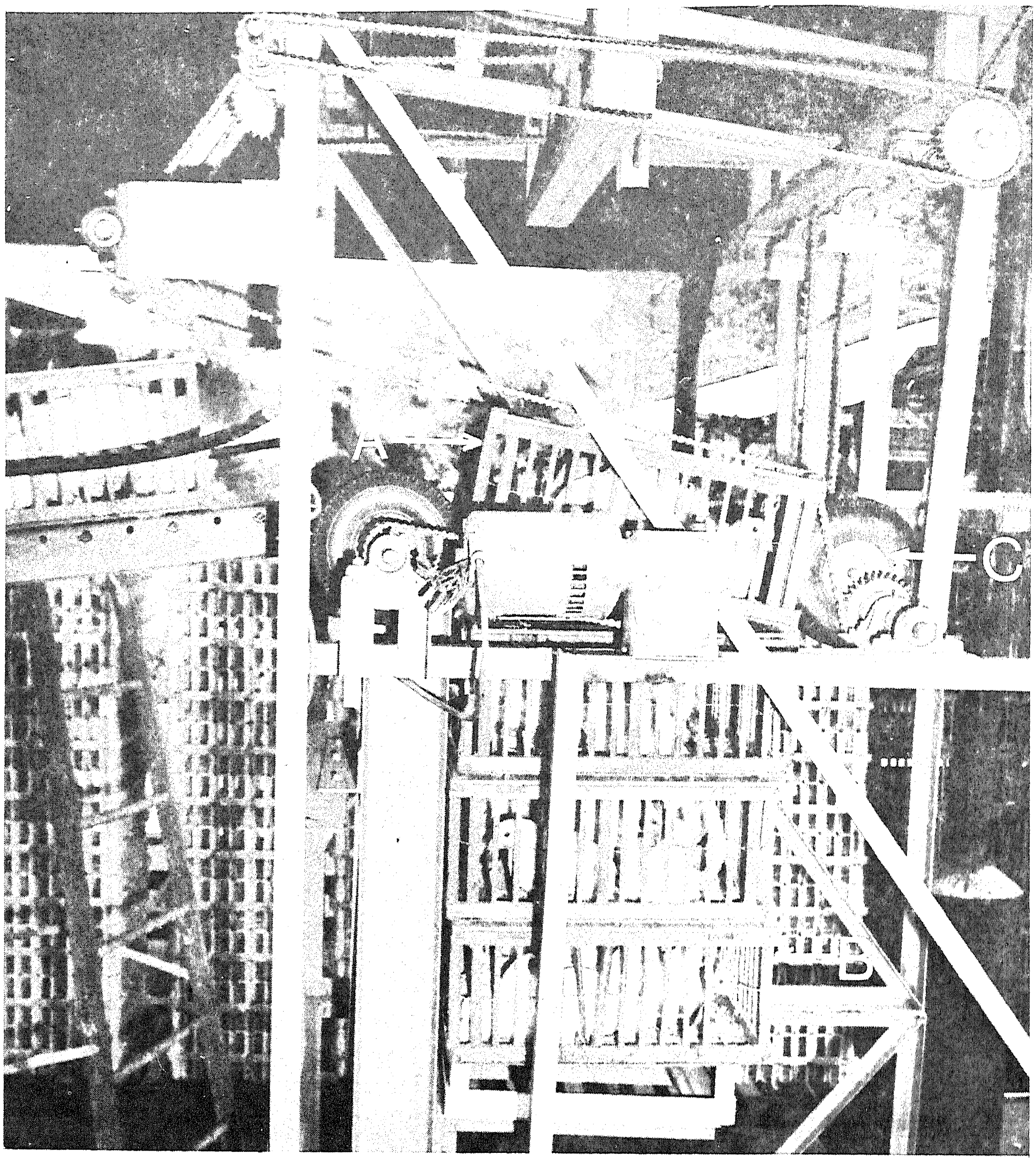

FIGURE 9.—Leading edge (A) of top coop in stack (B) being raised by discharge wheels. Rear-drive wheels (C) were removed on final design of experimental machine.

The coop (fig. 10) is sandwiched between the powered chains and the discharge wheels prior to ejection onto the conveyor leading into the plant. The following coop has already made contact with the powered chain and is being lifted by the discharge wheels. This process continues until the bottom coop is ejected and the lift platform contacts the limit switch 5 (LS–5, fig. 1), at which time the upward motion of the platform stops. Limit switch 5 energizes a time-delay relay, which holds the platform at the top position for 1 second. The platform must remain stationary for a short interval of time while the bottom coop is being discharged. At the end of the delay period, the relay reverses the ball-bearing screw-drive unit, and the platform descends until contact is made with limit switch 3 (LS–3, fig. 1). This switch deenergizes the drive unit, reverses the motor starter contacts for the screw drive motor, and energizes the tower and powered feed conveyors. These conveyors advance another stack of coops

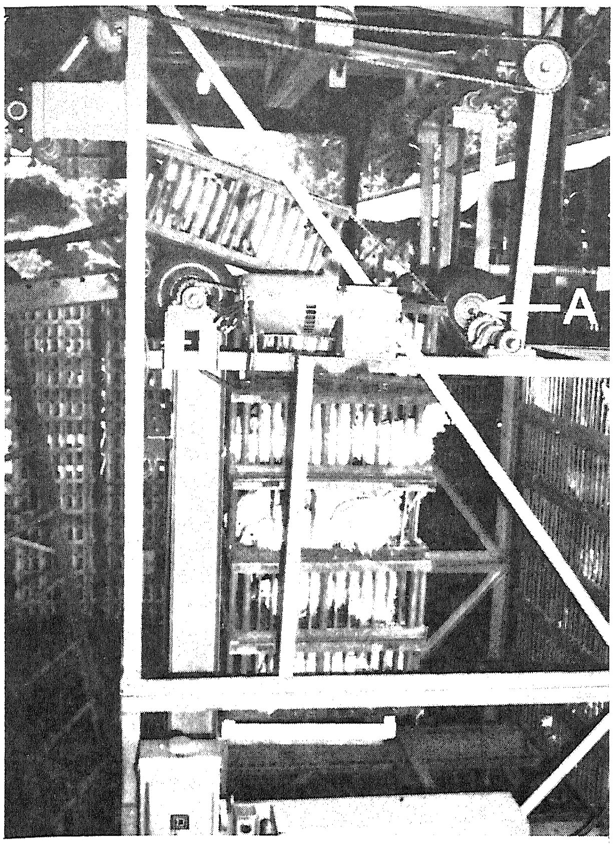

FIGURE 10.—Position of coop at discharge conveyor.

into the tower and position another on the feed conveyor, and the platform cycle is repeated. Limit switch 6 (LS–6, fig. 18) is located approximately eight coop lengths from the discharge wheels on the discharge conveyor. This switch controls the unstacker when the discharge conveyor is fully loaded with coops, thereby eliminating coop backup on the discharge conveyor. The unstacker continues to cycle through these operations as long as coops are available on the feed conveyor.

FIELD TEST RESULTS

The unit was installed at a processing facility for testing under commercial operating conditions. The processors furnished a squeeze-lift truck and operator to load the powered feed conveyor with stacks of coops. The discharge conveyor was connected to an existing conveyor system to supply full coops of chickens to the hanging stations. Truckloads of 10-inch wooden coops, plastic coops, and mixed stacks of plastic and wood coops were run through the system.

The major problem encountered in the field tests was coops with badly damaged bottoms hanging up on conveyor rollers as they were conveyed from the tower. This problem could be solved through daily inspection of coops and by retiring damaged coops from use. Coops with broken dowels and in a rickety condition ran smoothly through the system. Stacks of coops up to 4 inches out of alinement were successfully run through the unstacker because crooked stacks were straightened by the action of the tower conveyor and the powered tension chains. Wet and dry coops were run through the system with no significant difference in the effectiveness of the operation.

Coop damage that could be attributed to the unstacker was minor. Coops run through the unstacker 20 times or more showed a slight rounding effect on the leading edge of the top slat. This occurred where the edge of the slat and the powered tension chain met. This is not considered serious enough to affect the normal expected coop life.

Because of the smooth flow of coops through the unstacker, bruising normally attributed to rough handling of coops at the receiving dock is reduced. Since the coops are not dropped or thrown as in some handling methods, coop life is also extended.

The design production rate of 16 coops per minute was exceeded. Based on test results, the prototype unit handled more than 20 coops per minute with coops stacked 6 high. Production could be increased beyond this with the unstacker constructed to handle higher stacks.

PLANS

The drawings presented in figures 11 through 18 illustrate the main components of the unstacker. The dimensions were taken from the prototype.

All of the drives, bearings, chains, shafts, and cam followers are standard stock items. Hot-rolled angle, channel, and plate steel were utilized throughout the design. Special items were the tension springs and the ball-bearing nut and screw. The ball-bearing screw was ordered complete with each end factory-machined. These units are available through dealers in different sizes and lengths. The electrical controls are standard stock items with industrial suppliers.

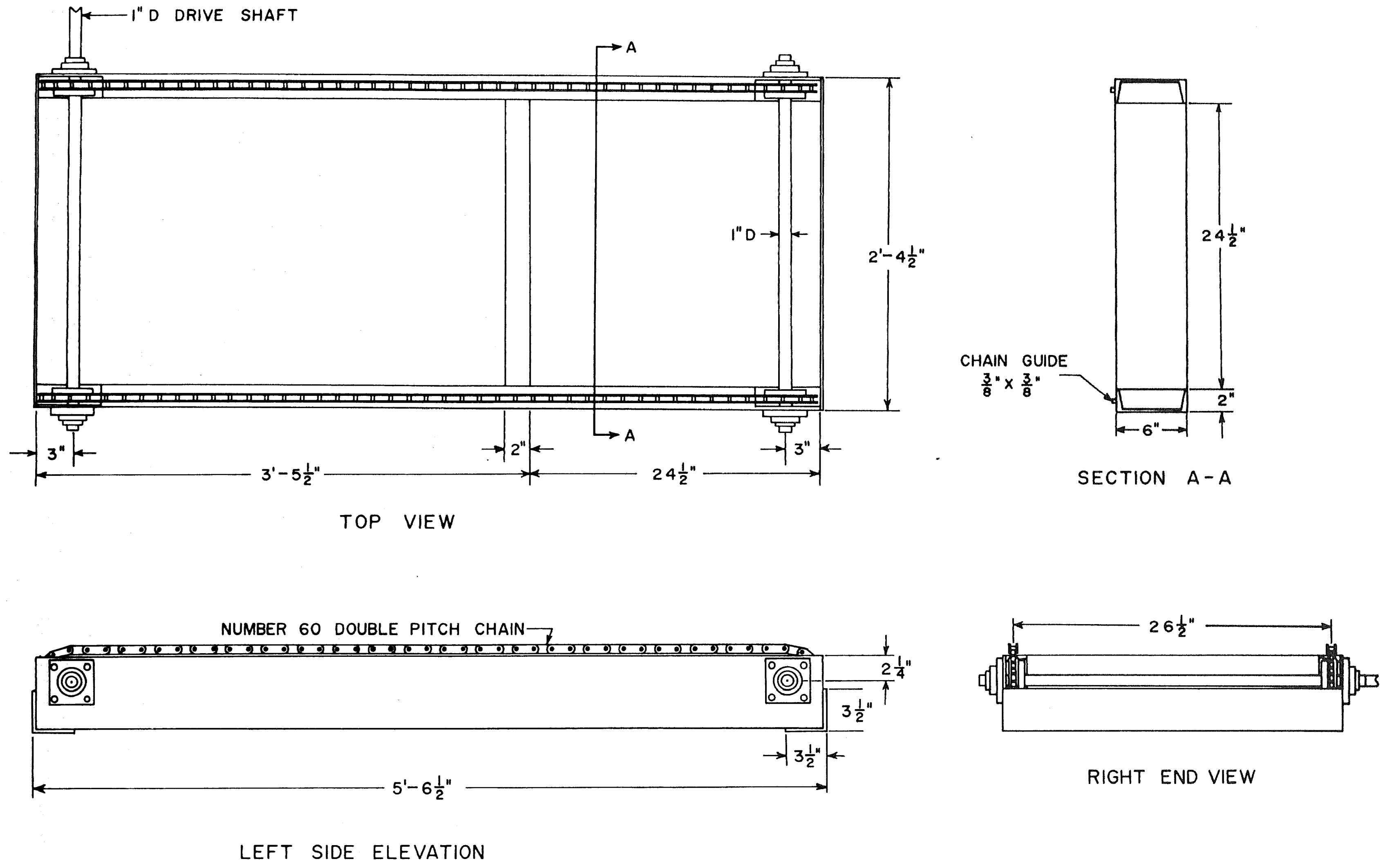

FIGURE 11.—Tower conveyor detail.

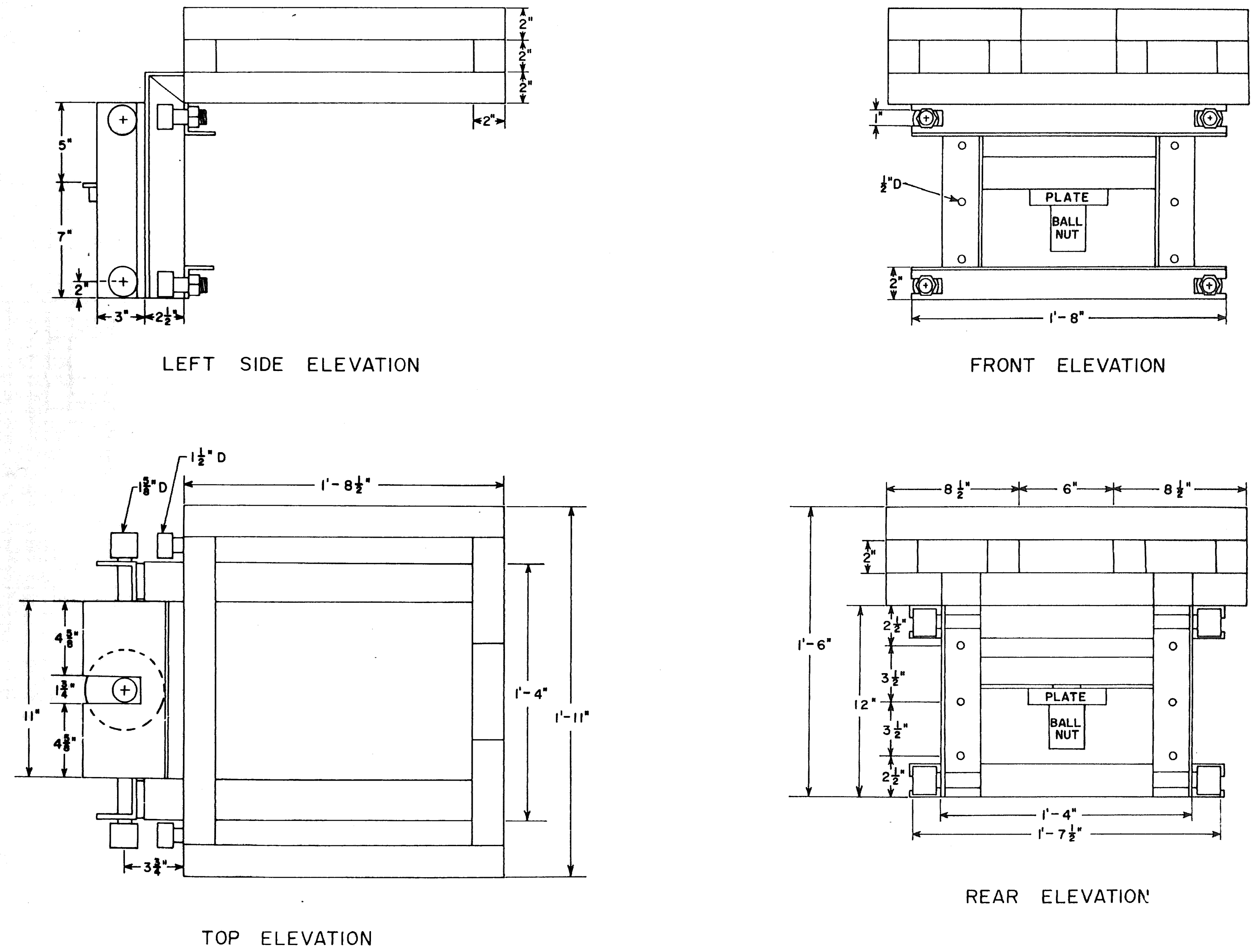

Figure 12.—Lift platform detail.

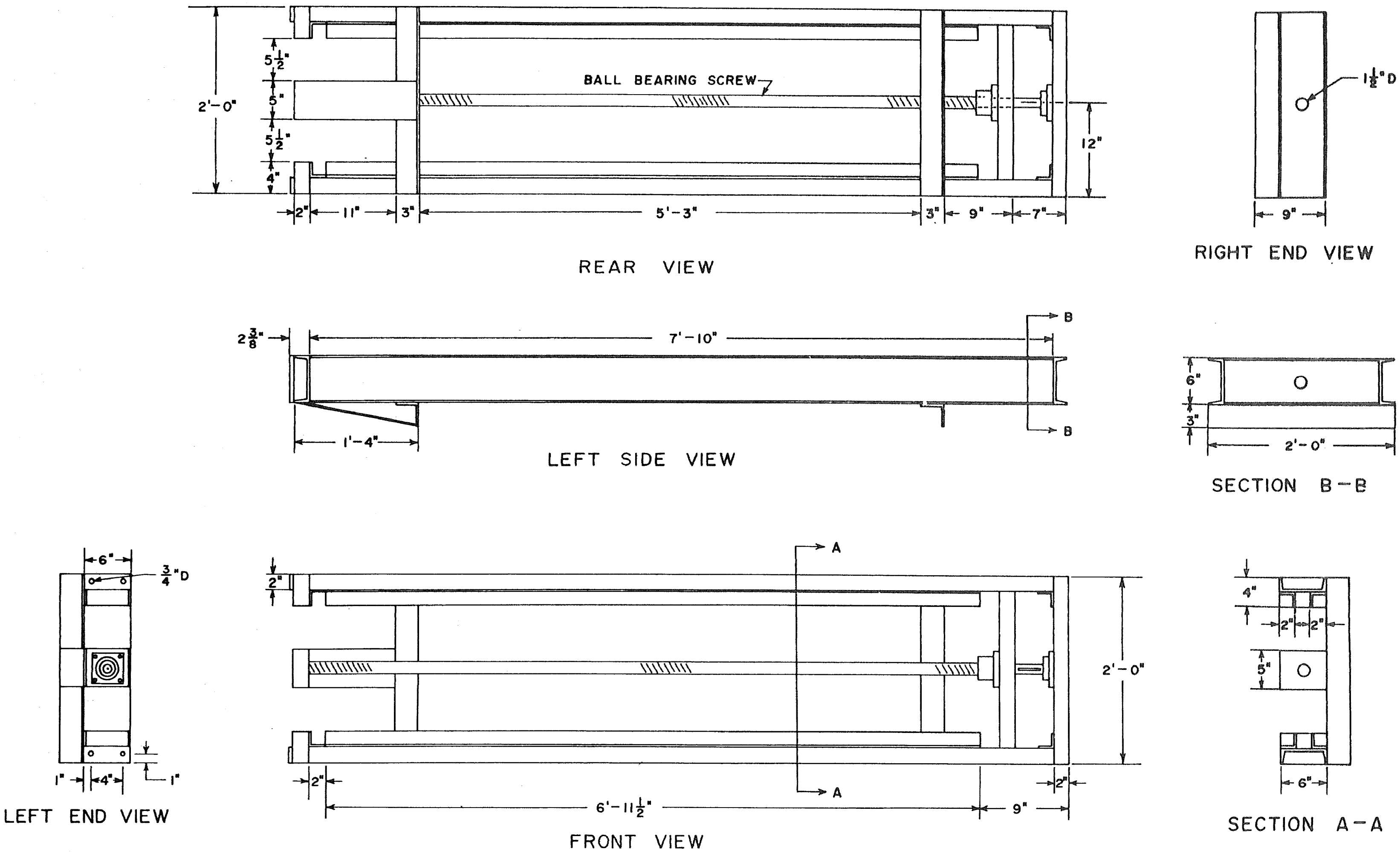

FIGURE 13.—Platform track frame detail.

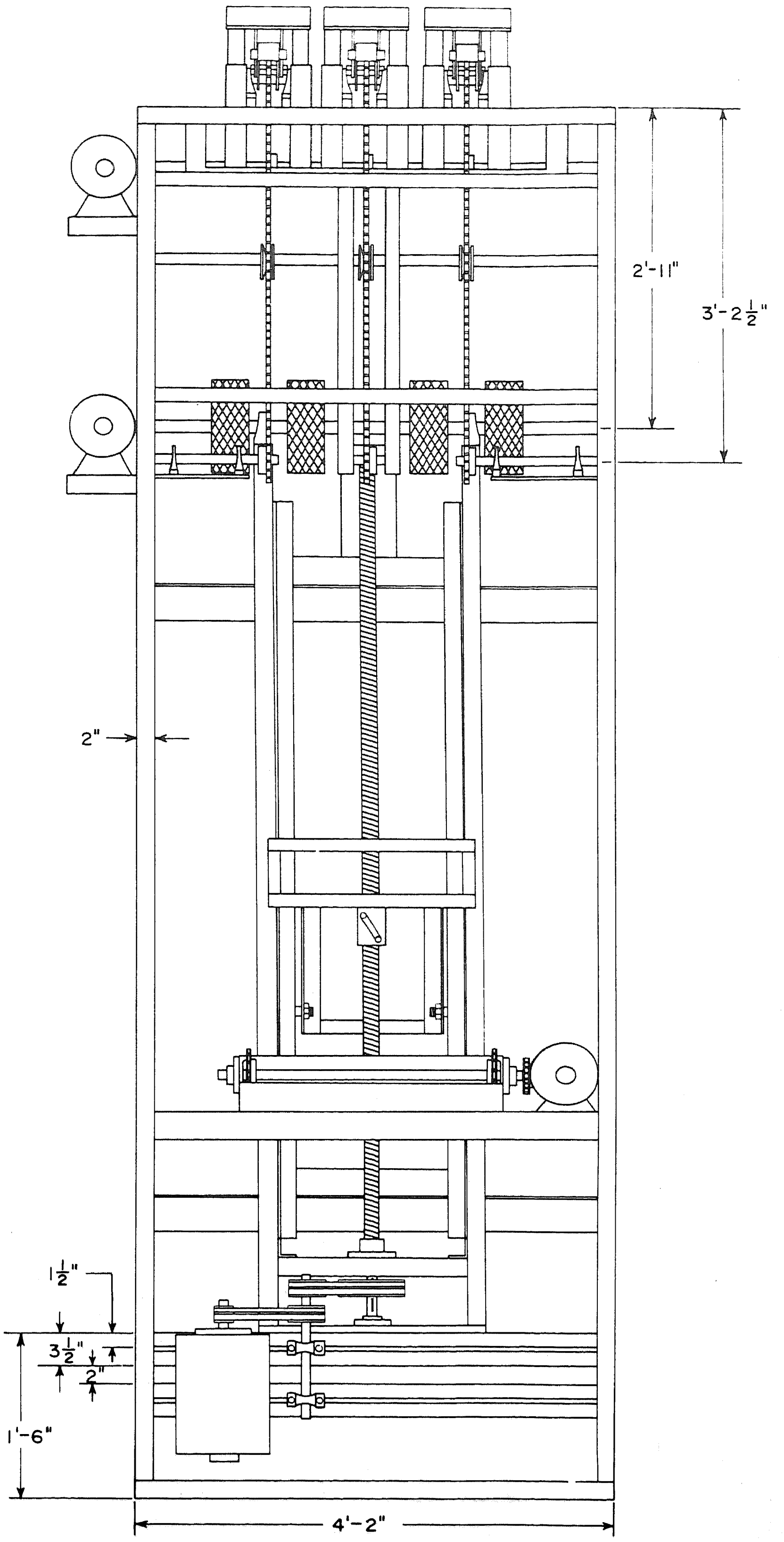

FIGURE 14.—Front view of unstacker, showing lift platform.

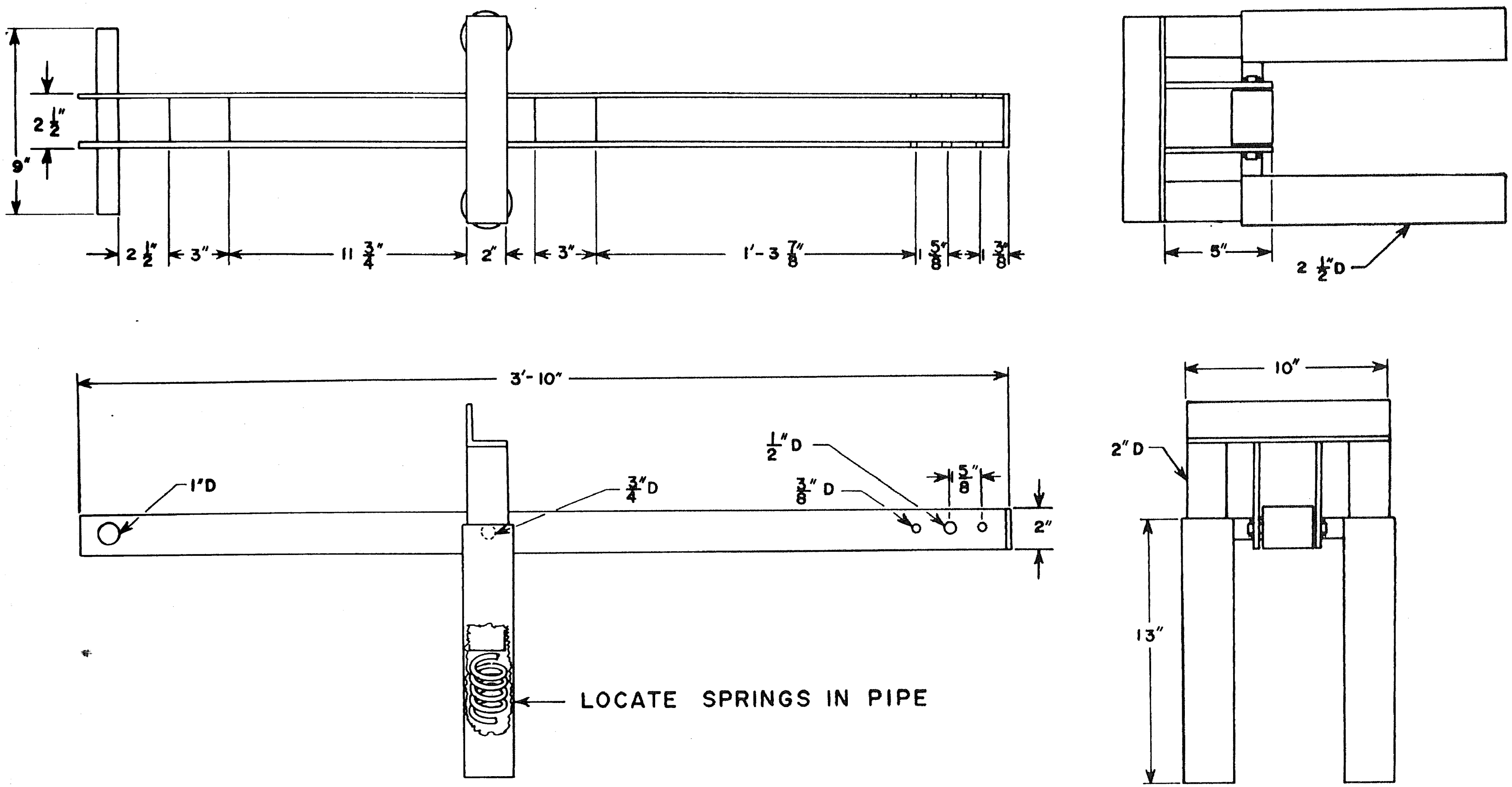

FIGURE 15.—Tension arm assembly details.

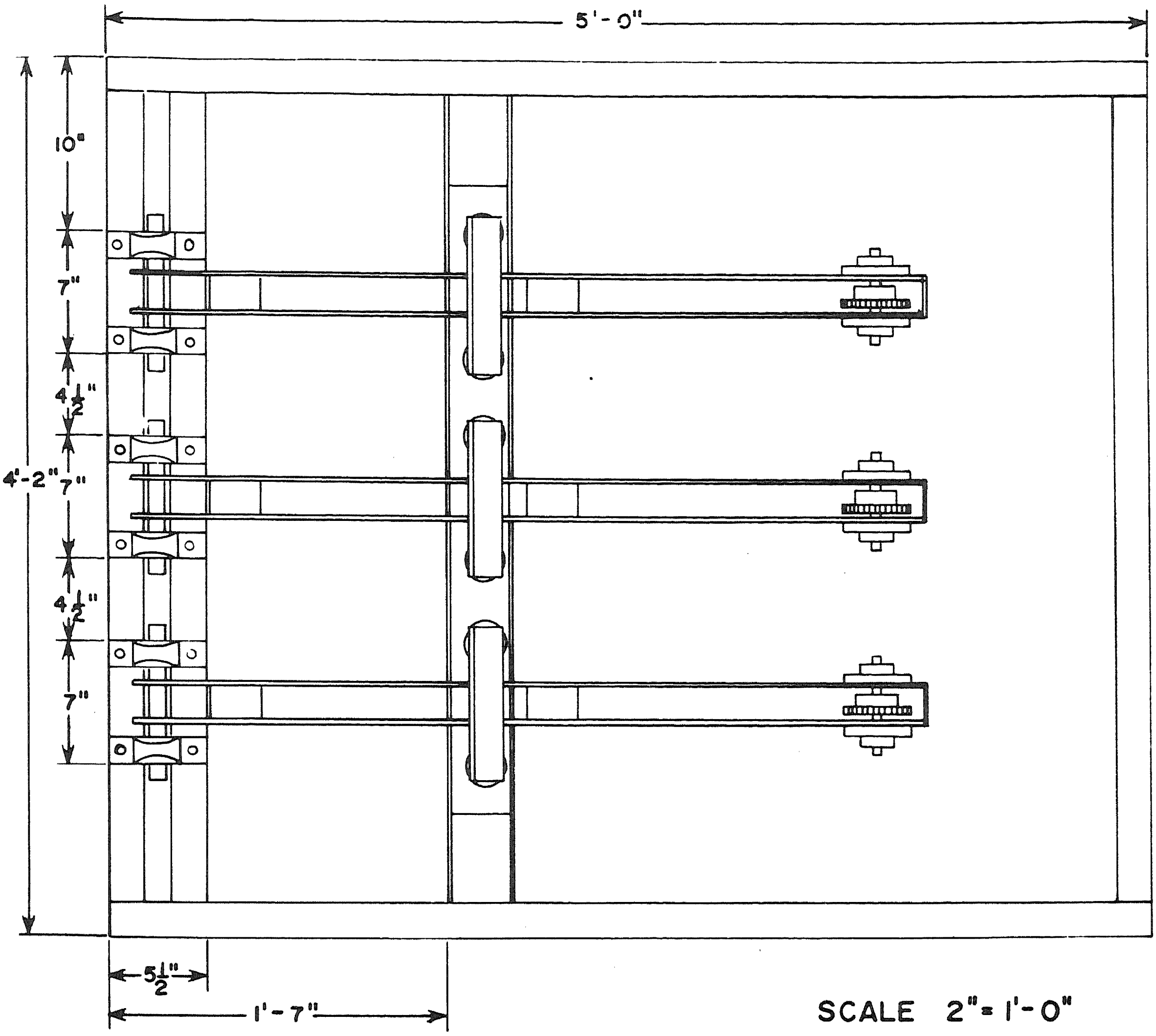

FIGURE 16.—Location of tension arms on top of unstacker.

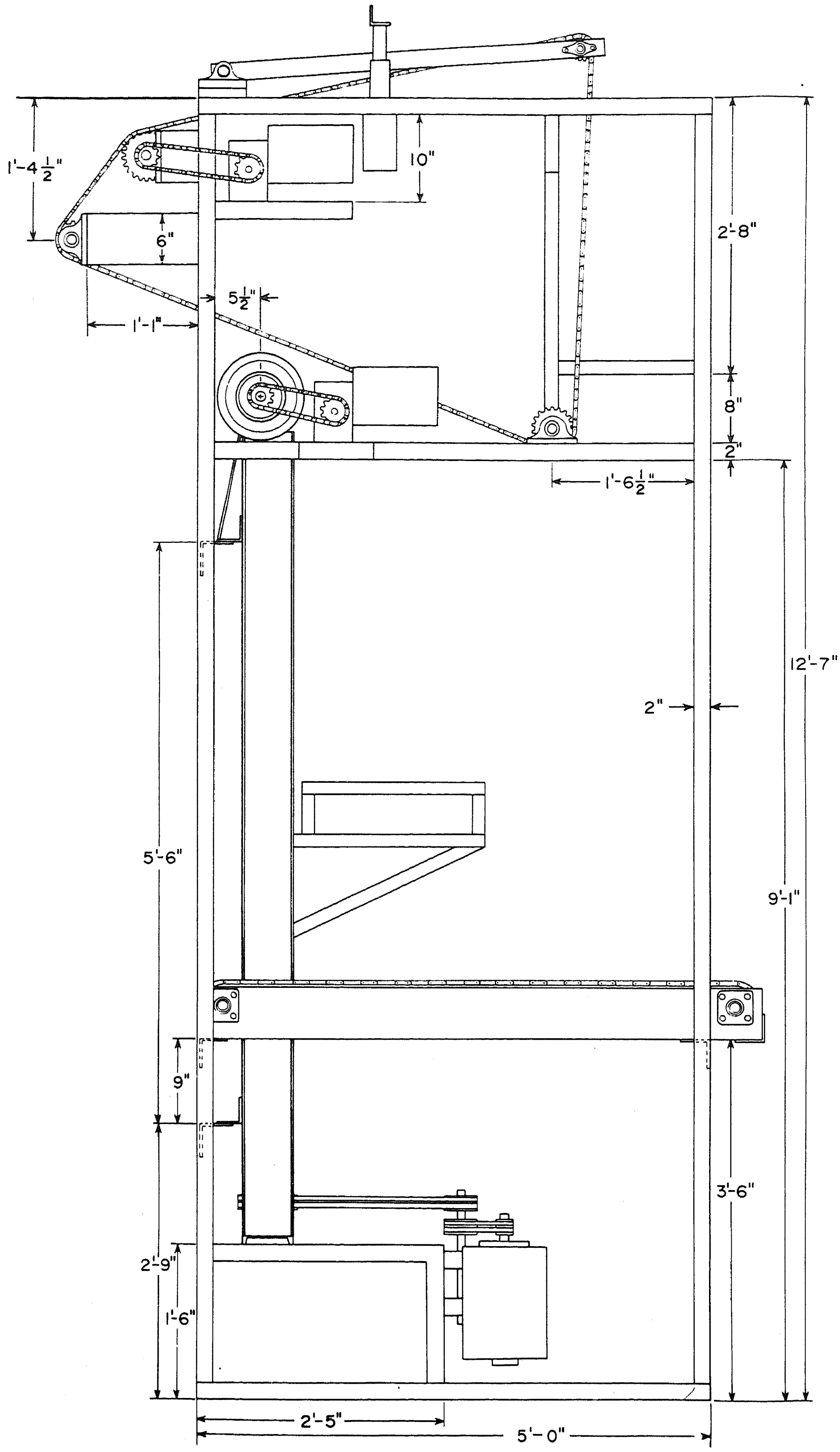

FIGURE 17.—Left side view of unstacker.

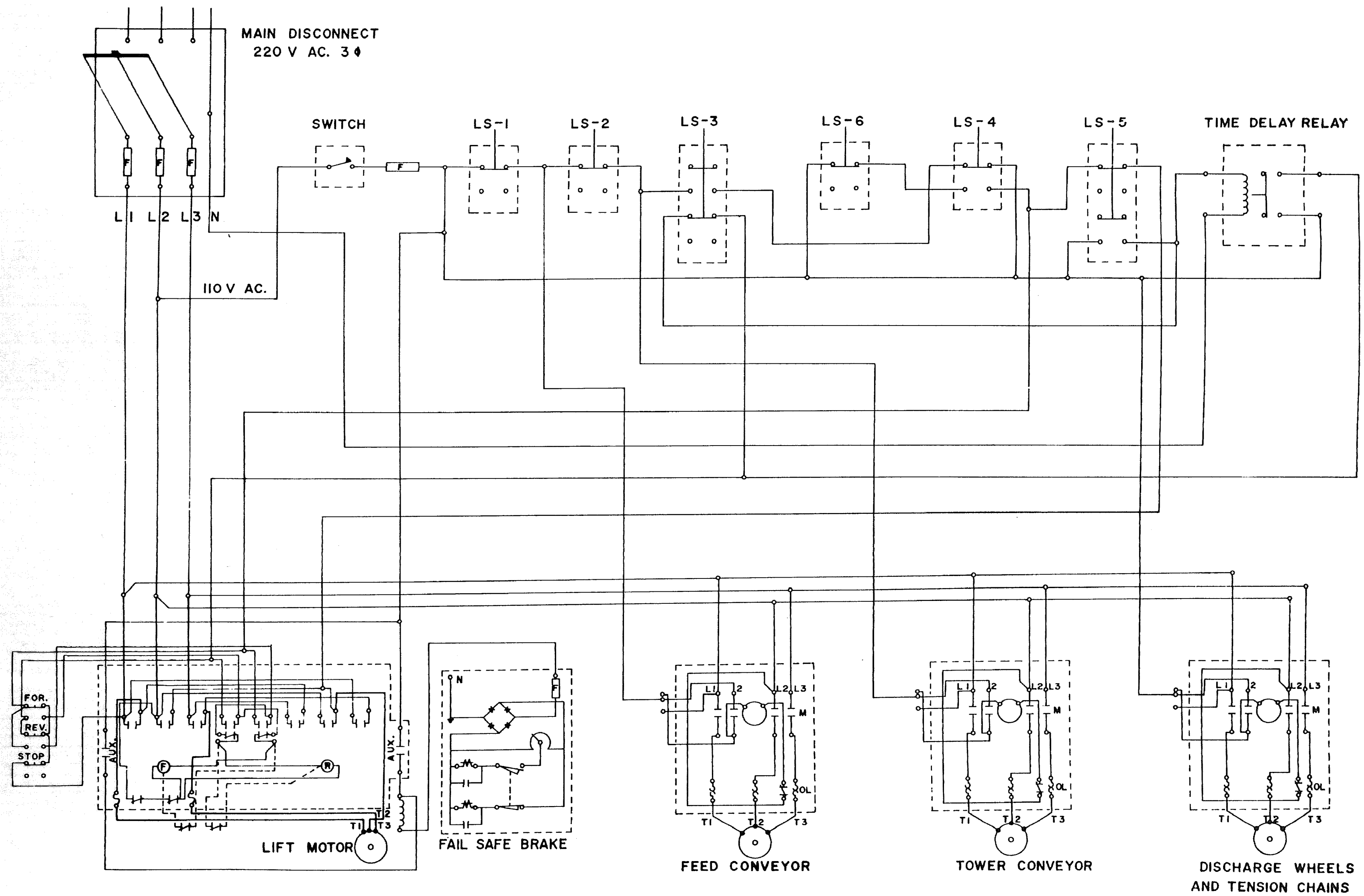

FIGURE 18.—Wiring diagram.